The Growth of Seedlings in Wind.

By Leonard Hill, M.B., F.R.S. (Director of the Department of Applied Physiology, National Institute for Medical Research).

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[Plates 2 and 3.]

The stunting of plants, and their more twisted, bent, and harder woody nature is seen in wind-swept places, for example, the exposed shores of the Shetland Islands. In Patagonia, where no shrub grows more than a yard or so high, there is sunshine by day and ceaseless wind—an ideal spot for open air treatment. Gardeners use hedges and rush hurdles as wind screens, and secure luxuriant growth in exposed gardens by providing such shelter. The kata-thermometer* gives a measure of the cooling and evaporative power of the wind on its dry or moist surface at body temperature, and the powerful effects of an open-air life with exposure to wind on the human body have been studied. It seemed of interest, then, experimentally to study the effect of wind on the germination and growth of seedlings. Mustard and cress seeds were grown on lamp-wicks, which were kept moist by their ends dipping in basins of water.

The control seeds, in the relatively still atmosphere, were grown within a glass jar on a damp lamp-wick. The jar was placed horizontally, with one end of the lamp-wick dipping in a saucer of water. The seeds exposed to wind were grown in a glass jar, the bottom of which had been removed, and the neck inserted in the opening of the electrically driven fan, so that air was sucked, or blown, through the jar at the rate of approximately 5 metres a second. The lamp-wick in this case also dipped into a basin of water placed outside the jar. The blower-fan used was one made by Keith Blackman, and was of the type used for ventilating war-ships. It ran day and night with smoothness, and never failed during the whole course of the experiments, which lasted many weeks.

Some of the seeds exposed to wind did not sprout, some just sprouted, and a few just showed two green leaves on the end of a very short sprout, which was bent and horizontal; the contrast with the control being very striking. While the lamp-wick exposed to wind was quite moist, it appeared as if the upper surface of the seeds exposed to wind might not be wet enough for growth.

* Leonard Hill, 'The Science of Ventilation and Open-Air Treatment.' Spec. Rep. Series. Nos. 32 and 52. Med. Research Council.

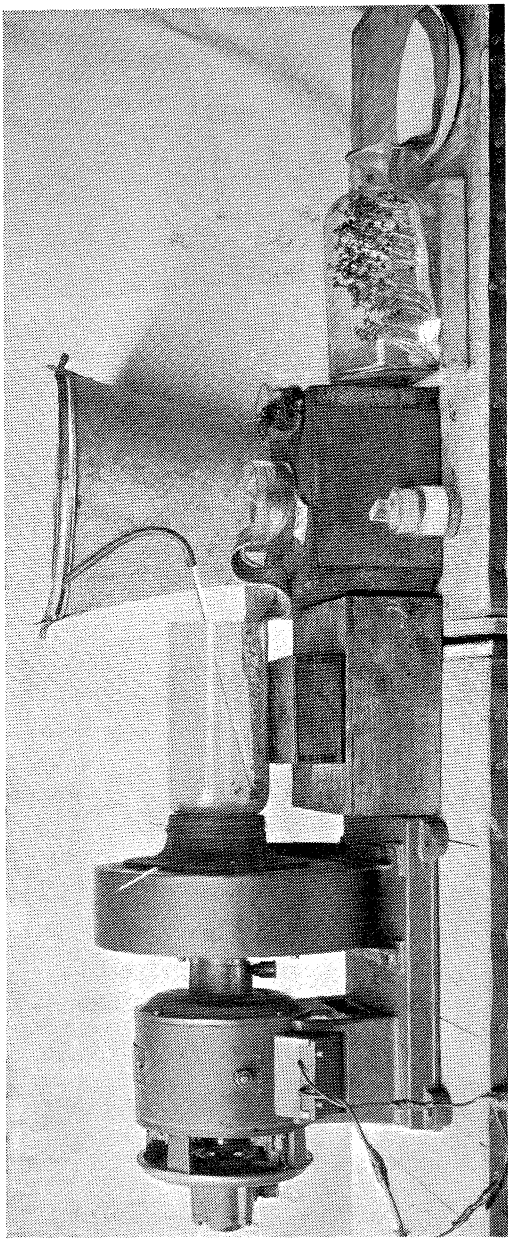


Fig. 1.

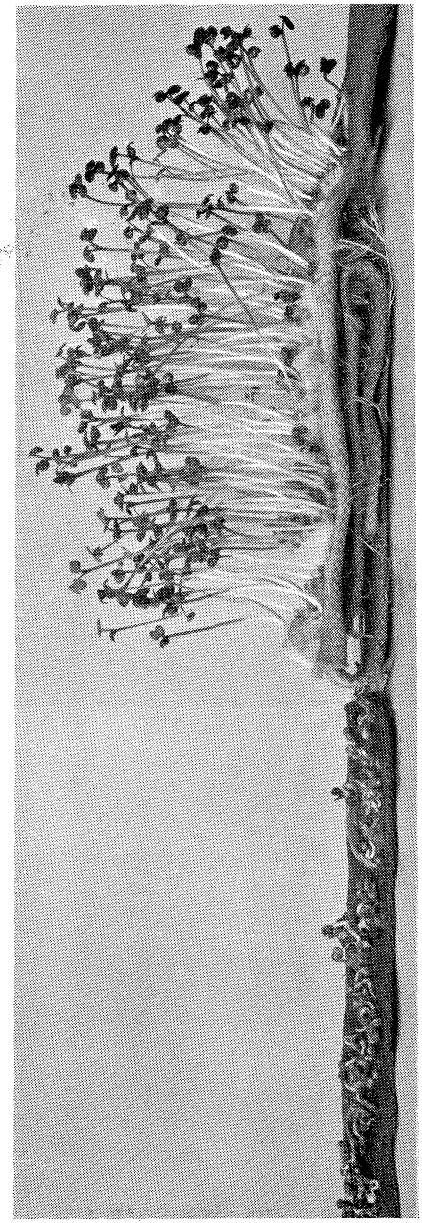
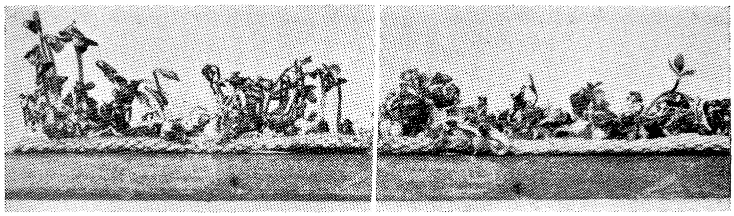


Fig. 2.



A FIG. 3. B

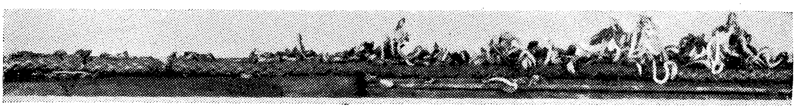
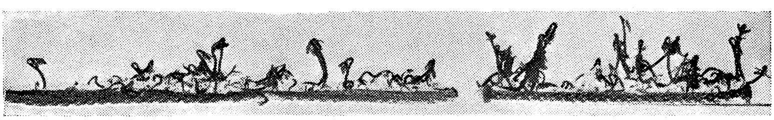


FIG. 4.



B FIG. 5. A

Experiment II was arranged, therefore, as shown in Plate 2. By means of a pail of water, and a syphon tube ending in a glass capillary tube, a gentle trickle of water at room temperature was kept flowing along the wick. Fig. 2 shows that the growth of the seeds exposed to wind was vastly less than the control. The seeds sprouting in the wind were bent close to the wick, and none of them showed root-hairs, which were abundant on the control seedlings.

Experiment III.—Part of the lamp-wick, with some of the control seedlings on it, was transferred to the wind jar for a few days. The seedlings maintained their upright position, did not dry up and wither, but grew very slowly if at all.

Experiments IV, V, and VI.—Experiment II was repeated in warmer surroundings, and the wind which was made to blow through the jar scattered an abundant supply of water spray over the seeds. The results were of the same order, but the growth a little greater. The following determinations were made for me by Mr. A. Webster from random samplings :—

	Still-air seedlings.	Wind-exposed seedlings.
	Mustard.	
Average length of plant	55 mm.	22 mm.
Total solids	8·3 per cent.	21·3 per cent.
Water	91·7 ,,	78·7 ,,
Protein	30·0 } per cent. of total solids	26·8 } per cent. of total solids.
Ash	7·8 }	8·4 }
	Cress.	
Wet weight of 40 plants	0·7616 grm.	0·5139 grm.
Total solids	8·4 per cent.	13·3 per cent.
Water	91·6 ,,	86·7 ,,
Protein	31·2 } per cent. of total solids	27·3 } per cent. of total solids.
Ash	14·8 }	19·7 }

The bent, contorted, wind-exposed seedlings have, when straightened out, one-half to one-third the length, and contain more solids, less water, more ash, less protein, and, presumably, more cellulose.

Experiment VII.—A piece of cotton net (ladies' veiling) was placed over the seeds so as to anchor them and prevent the wind and water moving them. The conditions were otherwise the same as in Experiment II. A water film formed over the meshes of the net, and the seeds grew under the shelter of this, raising the whole net as they grew. The growth of the control and the wind exposed under these conditions were much more nearly equal.

Experiment VIII.—The pail of water shown in fig. 1 was heated by a gas-ring placed under it and fed by a tap, so that an outflow of warm water over

the seeds was maintained day and night, the whole being arranged conveniently over a sink, so that the waste water ran away. The wind was made to blow out through the jar and scatter the water spray along the seeds. Where the water entered the temperature averaged about 24–27° C. At the end of the wick near the opening of the jar the temperature averaged about 18° C., which was the average temperature of the control. Fig. 3, A, shows the still air, and B the wind-exposed seedlings. The latter shows a growth bent and twisted, but about two-thirds as long, when straightened out, as the control. Analysis showed in this case:—

	Wind-exposed seedlings.	Still-air seedlings.
Average length	20 mm.	30 mm.
Weight of 50 plants	0·6455 grm.	0·968 grm.
Total solids	8·66 per cent.	8·2 per cent.
Water	91·34 „	91·8 „

A difference in size rather than in percentages of water and solid is noticeable. The wind-swept seedlings in all the experiments grew no root hairs, while these were abundant on the controls.

Experiment IX.—Fig. 4 shows the result of growing cress seeds in a hot room kept continuously at 37·5° C. The seeds grown in the wind were kept wet by water which dripped out from a glass tube, the end of the tube lying on the wick close to where the growth is seen to be best. At the left end of the wick the growth is nil, although the wick and the under surface of the seeds were wet. The drying of the upper surface of the seeds was sufficient to stop growth. In the intermediate part the growth was better with the increasing wetness of the seeds. The control was placed so that the water from the wick in the wind tunnel dripped upon it. This dropping rain especially favoured growth in the hot room. It was greater than that shown in Fig. 3, A. Seeds kept just totally immersed did not grow. The amount of moisture the seeds receive is obviously of very great importance.

Experiment X.—Fig. 5 shows the growth in the hot room in wind, B, and out of the wind, A, both wicks being irrigated by falling drops of water so as to make the conditions of water supply as exactly comparable as possible. The growth of the seeds in the wind is still behind that of the control. The approximate average length of five seedlings was 2·5 cm. in the wind and 3·0 cm. in the control. The weight of 26 seedlings minus the seeds was 0·315 grm. in the control and 0·284 grm. in the wind. The percentage of solids was 13·8 and 17·2 per cent. respectively.

The temperature of the wet wick was 29° in the control and 26° in the

wind. The evaporative cooling power of the wind may, therefore, have had an effect.

The retardation of growth cannot be attributed to the shaking produced by the motor, because seeds sheltered from the wind, but submitted to the shaking, grew as well as the control seeds.

The conclusion is reached that the stunting effect produced by wind is not only due to a less favourable wetting, but to greater cooling. The growing point may be robbed by wind of heat which is produced in the cellular growth processes—heat which facilitates growth.

I am much indebted to Mr. R. H. Davis, of Messrs. Siebe Gorman, Ltd., who gave me facilities for carrying on this research at a time when the National Institute of Medical Research was being used as a War hospital.

Reflex Times in the South African Clawed Frog.

By W. A. Jolly.

(Communicated by Prof. E. Sharpey Schäfer, F.R.S. Received November 1, 1920.)

(From the Physiology Department, University of Cape Town.)

This investigation was undertaken with the object of determining the times of certain reflexes in a species of frog which has not, so far as I know, already been used for the purpose, viz., the South African clawed frog or toad (*Xenopus lœvis*, or an allied species), and by analysing these times to obtain a measure of the delay in transmission of the reflex impulses in the spinal cord, or "synapse time." Spinal and decerebrate animals have been used as well as the intact frog. Einthoven's string galvanometer was employed to indicate the beginning of activity in the limb muscles.

It seemed desirable to eliminate, as far as possible, everything that would tend to introduce doubt into the interpretation of the records, even at the cost of making the experiments more troublesome to carry out. For this reason no strychnine or other drug was used. The spinal and decerebrate preparations were kept alive before experiment until the wounds were entirely healed and the frogs appeared to be in thoroughly good condition. Records were then taken from day to day, and the influence of temperature and of the period of survival after operation was studied. Any operative

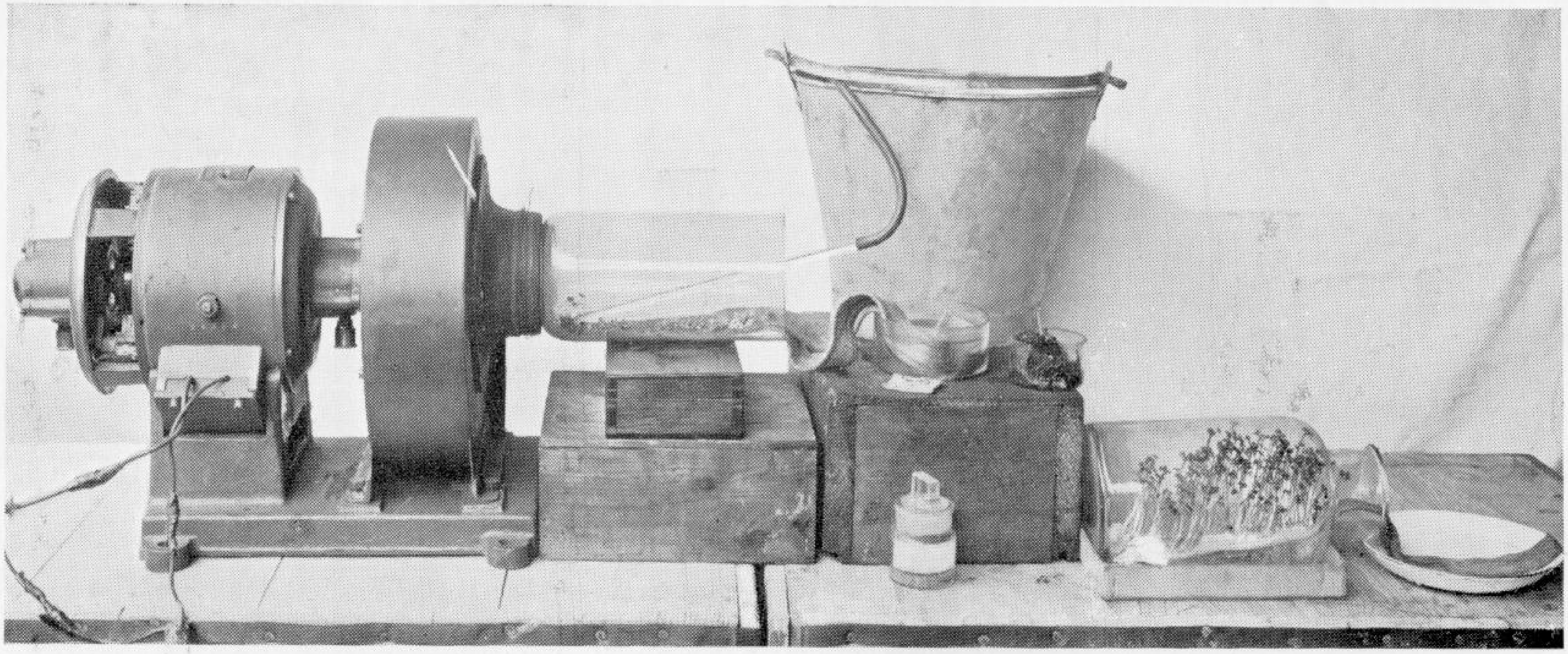


Fig. 1.

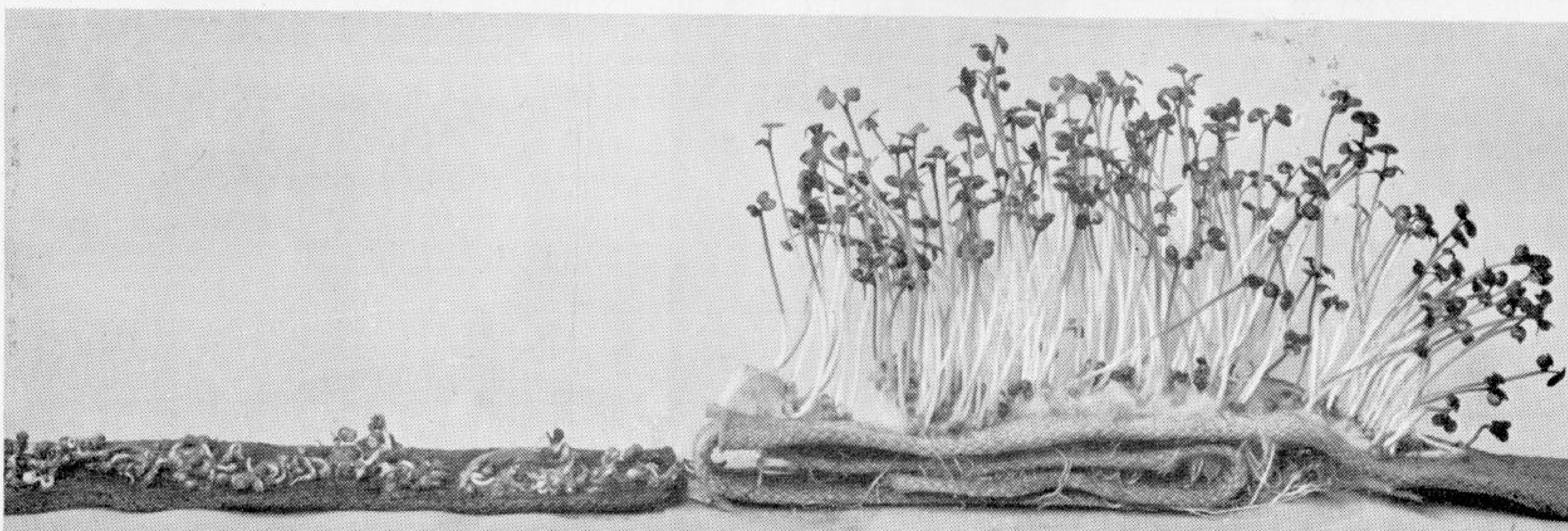
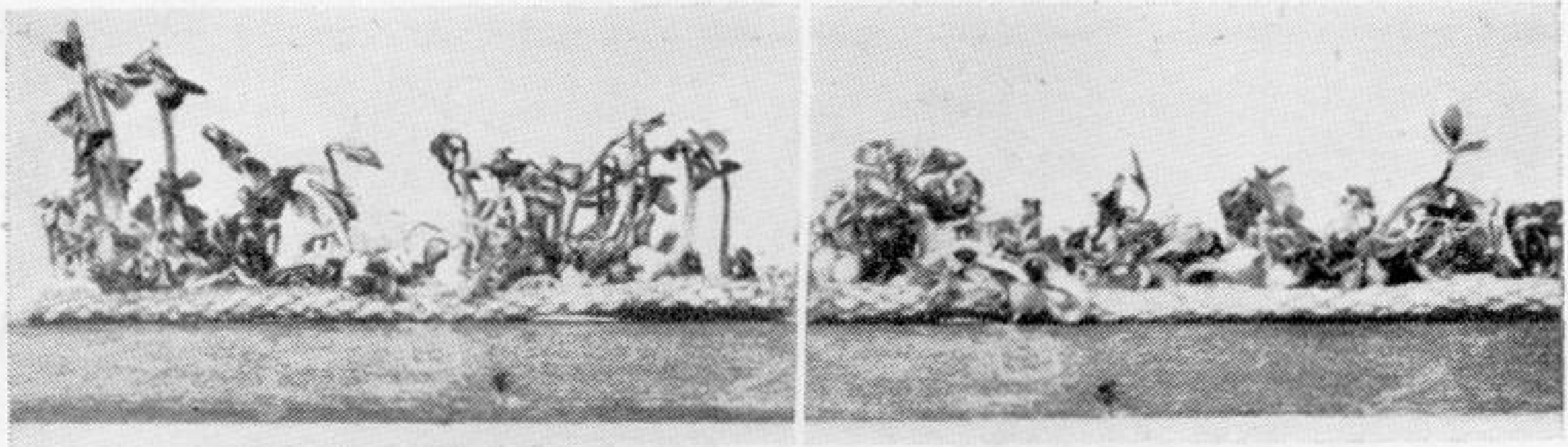
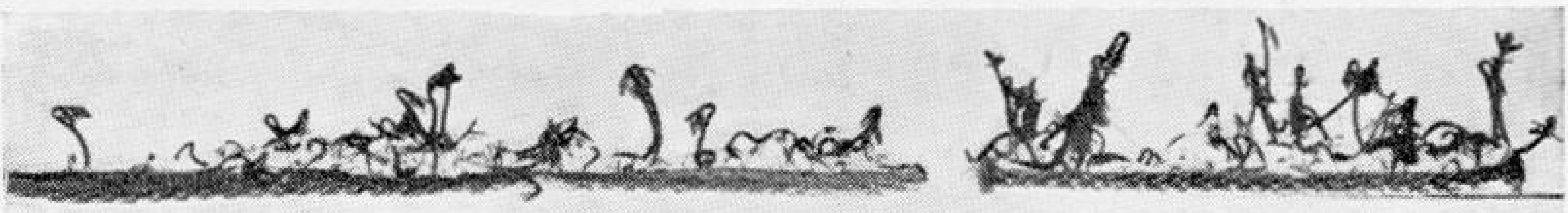


Fig. 2.



A FIG. 3. B

FIG. 4.



B FIG. 5. A